Further Improvements in SOFA Longwave Algorithms for CERES Edition-3

Shashi K. Gupta[1], David P. Kratz[2],
Anne C. Wilber[1], Victor E. Sothcott[1], and Taiping Zhang[1]

[1]Science Systems and Applications, Inc.
[2]NASA Langley Research Center

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Background

- CERES uses several surface-only flux algorithms to compute SW and LW surface fluxes in addition to the detailed model used by SARB. These algorithms include:

LPSA/LPLA:
Langley Parameterized SW/LW Algorithm

		Model A	Model B	Model C
SW	Clear	Li et al.	LPSA	--
	All-Sky	--	LPSA	--
LW	Clear	Inamdar and Ramanathan	LPLA	Zhou-Cess
	All-Sky	--	LPLA	Zhou-Cess

References:

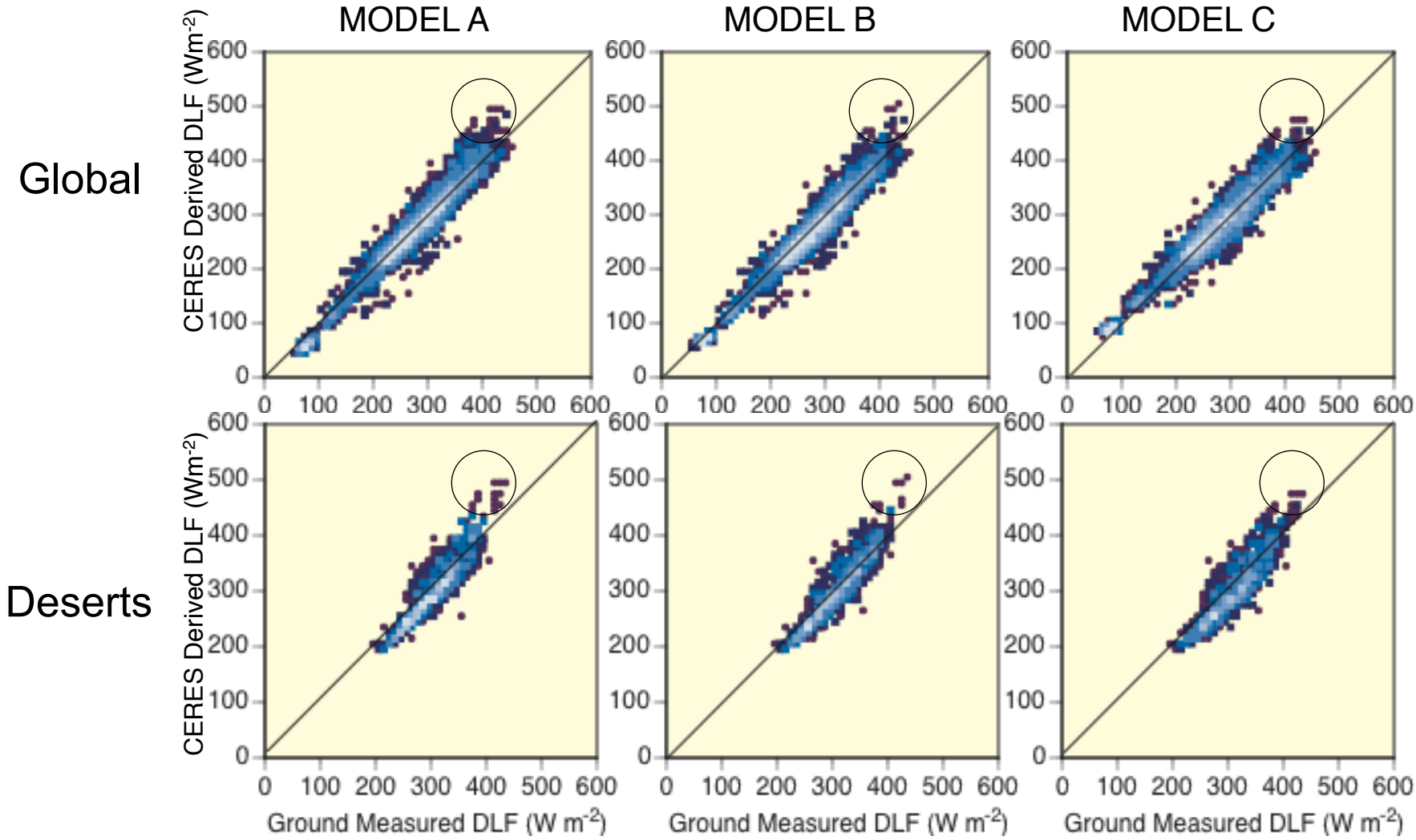
SW A: Li et al. (1993): *J. Climate*, **6**, 1764-1772.
SW B: Darnell et al. (1992): *J Geophys. Res.*, **97**, 15741-15760.
Gupta et al. (2001): *NASA/TP-2001-211272*, 31 pp.
LW A: Inamdar and Ramanathan (1997): *Tellus,* **49B**, 216-230.
LW B: Gupta et al. (1992): *J. Appl. Meteor.,* **31**, 1361-1367.
LW C: Zhou et al. (2007): *J. Geophys. Res.*, **112**, D15102.
SOFA: Kratz et al. (2009): JAMC, doi:10.1175/2009JAMC2246.1

Introduction

- LW Models A and B have been used in CERES processing since the beginning of the project.
- LW Model C will be introduced with Edition-3 processing to maintain two independent LW algorithms if CERES window channel becomes unavailable on future CERES instruments.
- Models A and B have undergone extensive validation. Model C has been tested thoroughly over the last year or so.
- Validation of models has shown deficiencies, some small, some not so small. As these deficiencies have come to our attention, we have made refinements to the models.
- This presentation is about the latest such incremental effort with regard to the SOFA LW models.

Overestimation of DLF Over Desert Regions

Clear-Sky (Aqua-2A; July 2002 - March 2005)

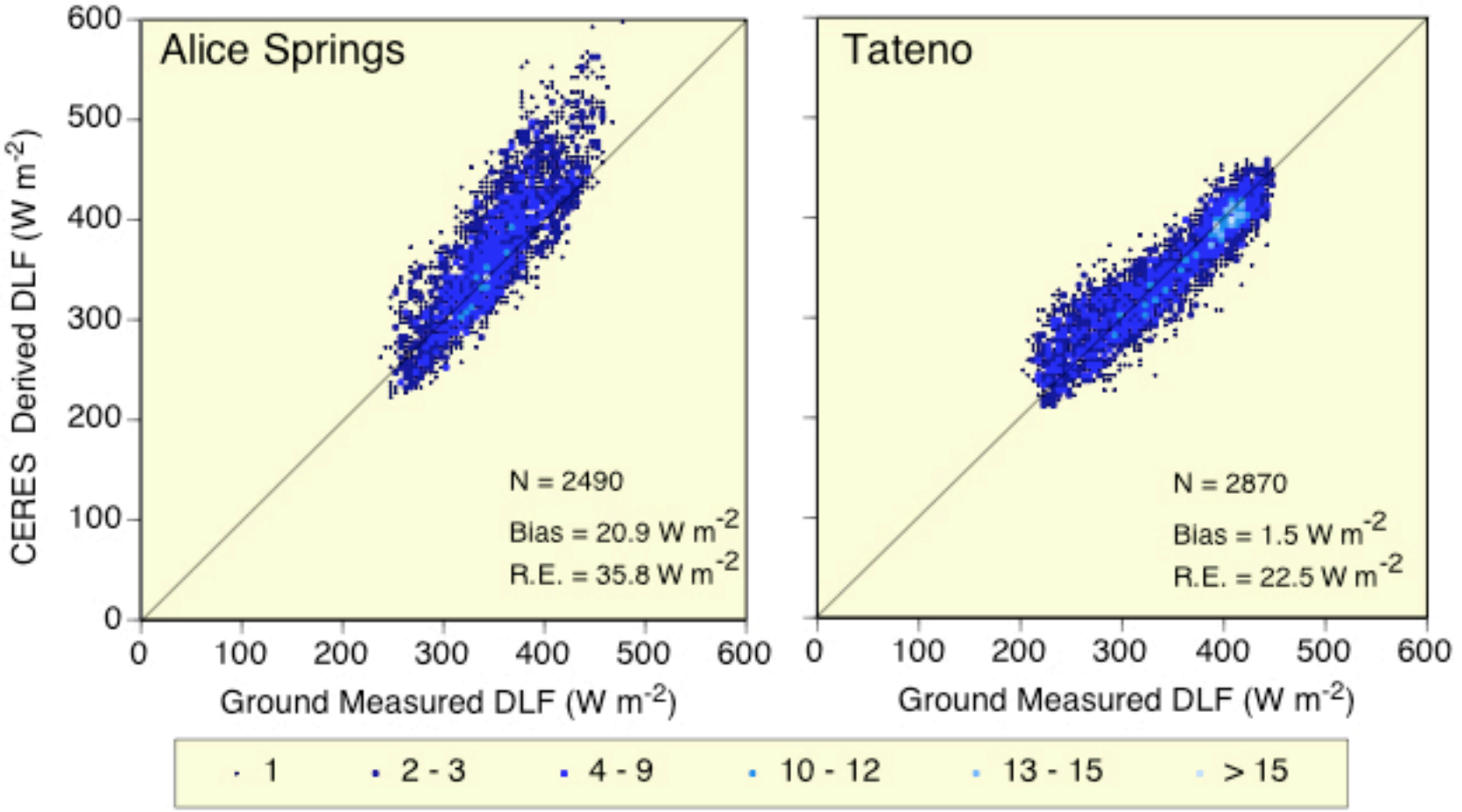


Investigation of Overestimation

- Investigation of the overestimation showed that it was most egregious over dry/arid regions. We identified two features of the models that were contributing to this behavior.
- First: All models make use of surface temperature either as a proxy for or to estimate the near-surface air temperature, and
- Second: All models assume a reasonable value of lapse rate in the lower troposphere.
- When the surface overheats, as happens frequently over desert sites, especially during times of high surface insolation, neither of the above conditions are met, and an overestimation results.
- A case study was conducted to identify the conditions under which overestimation occurs and a procedure developed to remedy it.

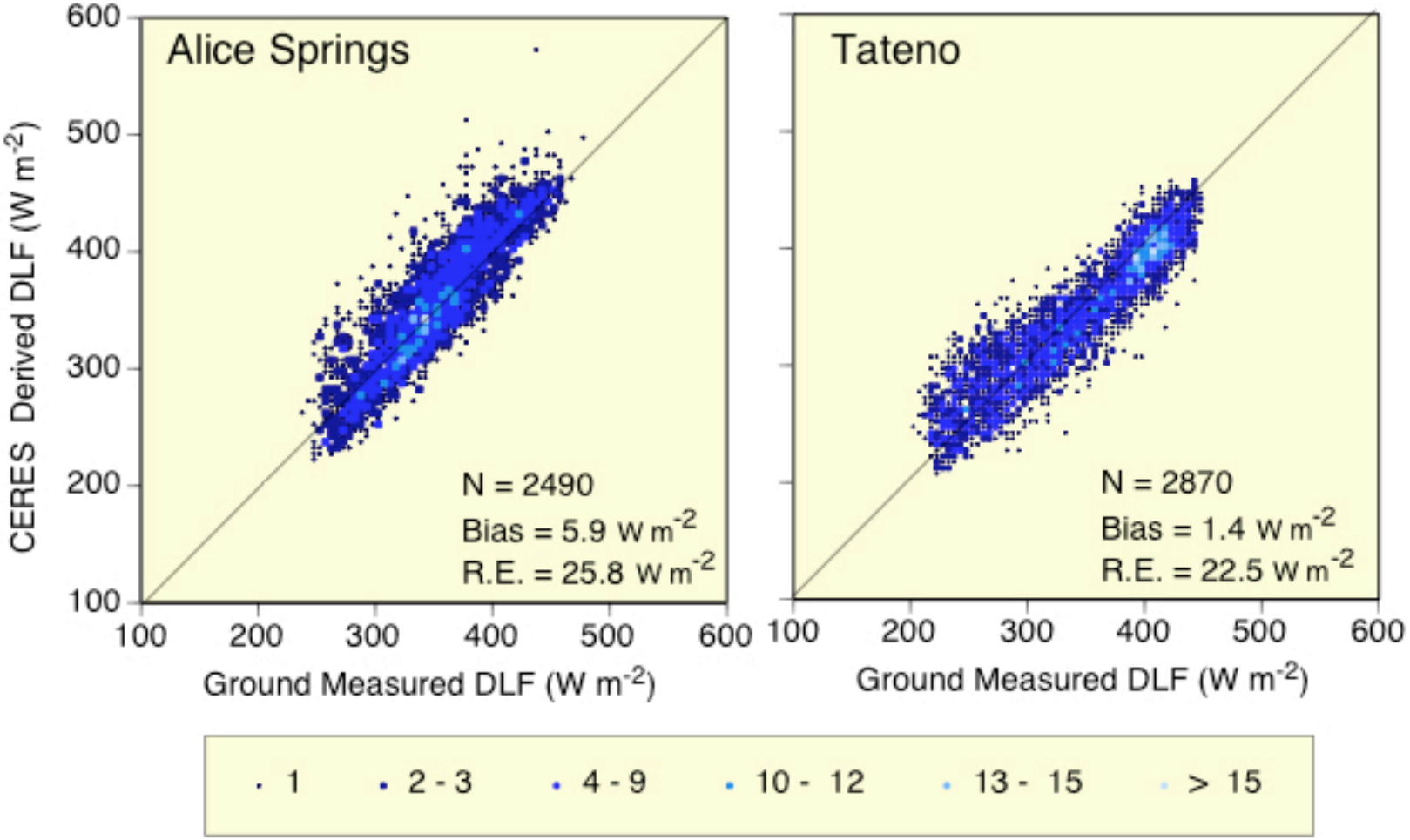
Model-Derived vs. Ground-Measured BSRN DLF

(Year 2004; Offline LW Model B)



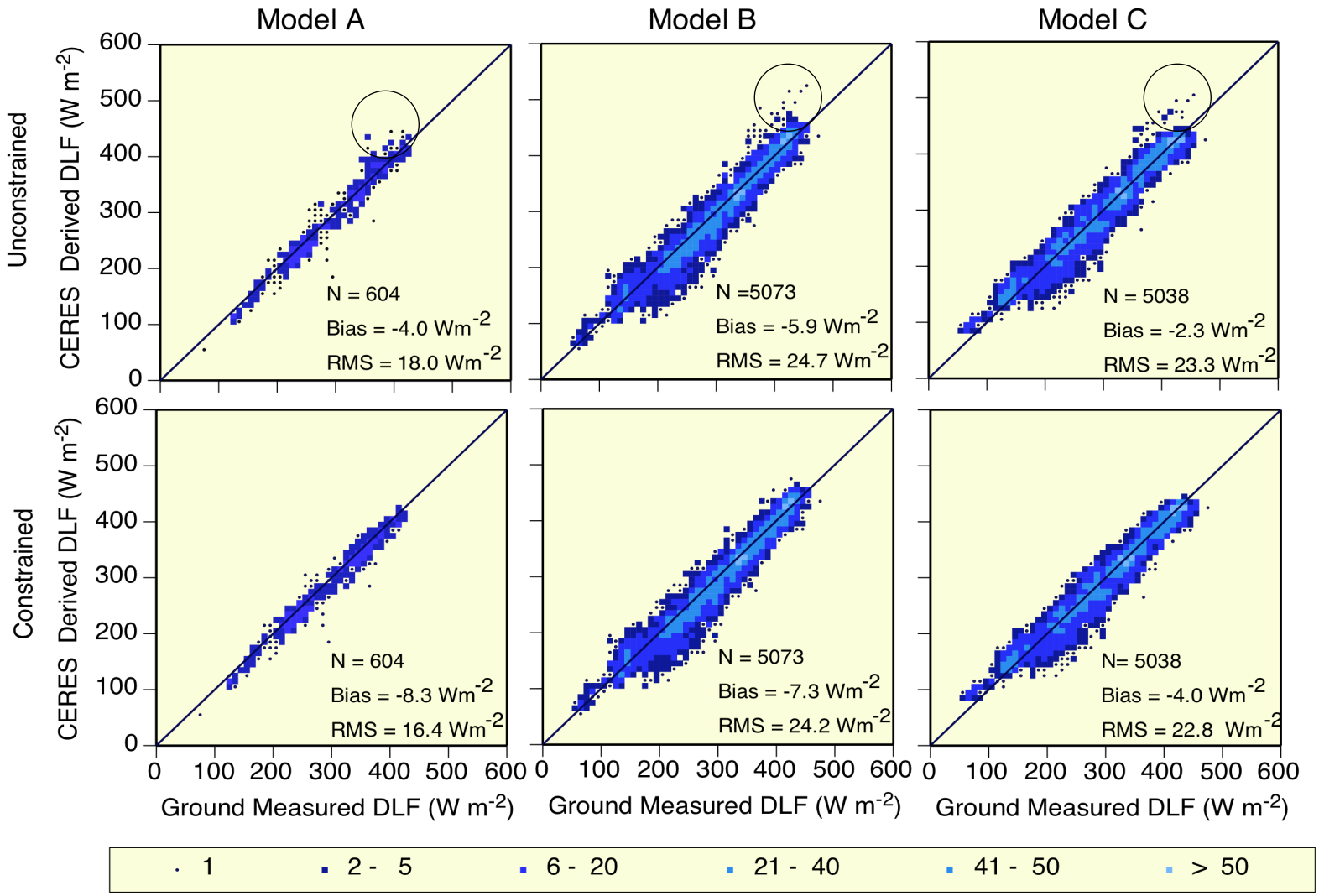
Significant overestimation over Alice Springs; almost none over Tateno

Results From the Modified Computation



Bias for Alice Springs - reduced greatly; Change for Tateno - minimal

Model Fluxes from CERES Processing – Jan & Jul 2004



Investigation of Underestimation

- Investigation of underestimation was necessitated because overheating correction revealed an overall negative bias in fluxes.
- Temperature inversion was easily identified. Initiated another case study using Model B. Effective emitting temperature in this model is computed as:

$$T_{eff} = 0.60\ T_s + 0.35\ T_1 + 0.05\ T_2\ , \text{ where}$$

T_s – Surface temperature (proxy for near-surface air temp.)

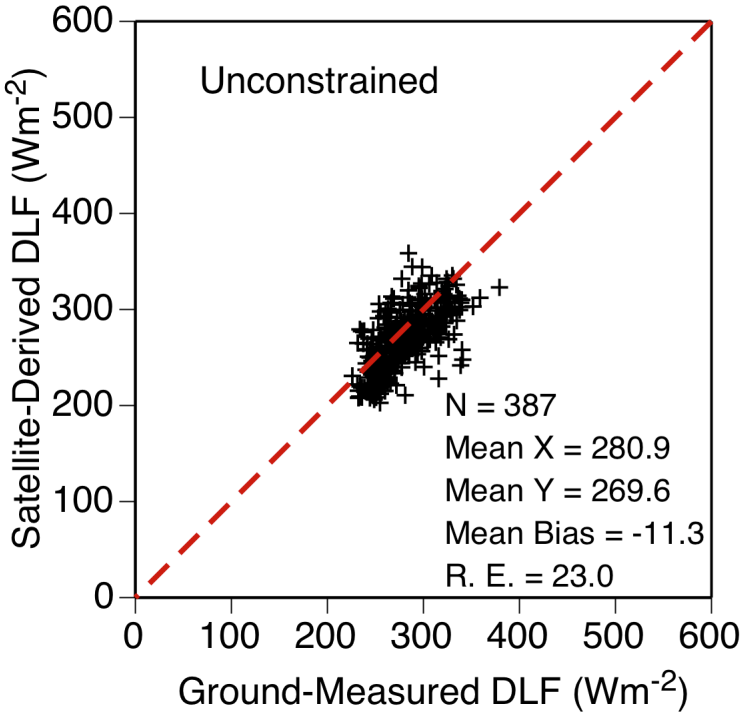
T_1 - Average temperature for Sfc. – 800 hPa layer

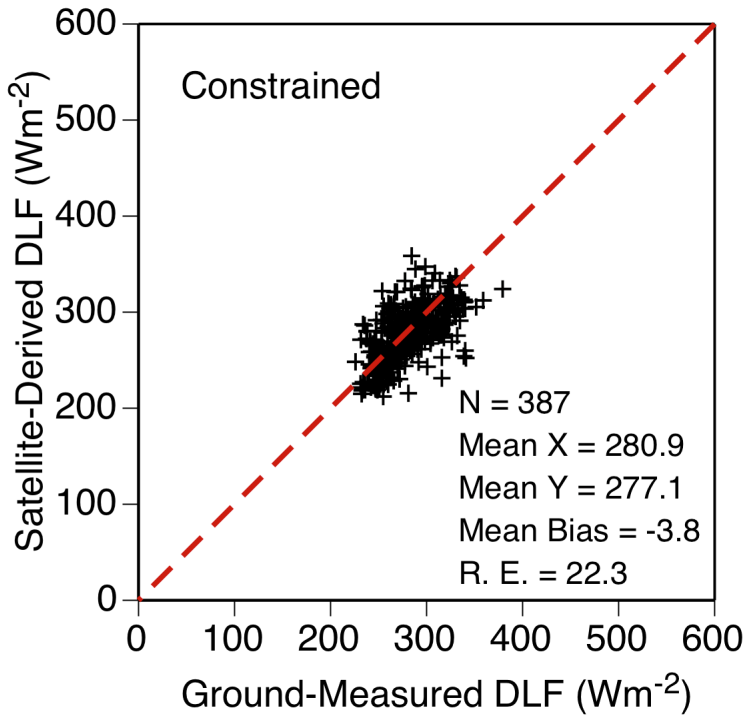
T_2 - Average temperature for 800 - 680 hPa layer

- When $T_s < T_1$, T_{eff} is lower causing underestimation of DLF
- Site chosen: Desert Rock, NV (DRA). Numerous profiles show inversion (more during cooler months) and while many others show overheating (more during warmer months).

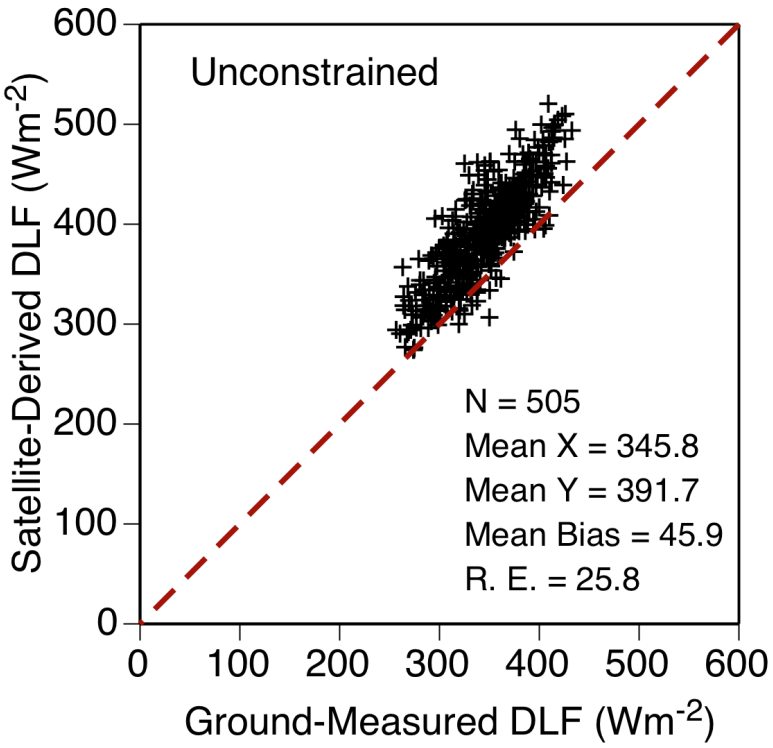
Case Study for Inversion

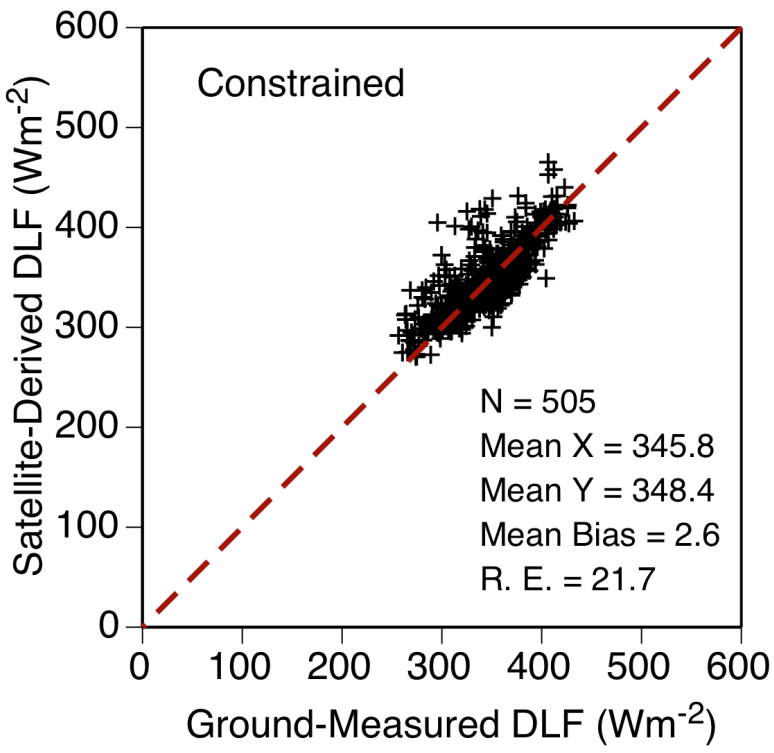
- Defined inversion as $T_s < T_1$. Separated DRA profiles that met this criterion. Constrained near-surface air temperature (T_s) to be equal to T_1. Computed 3-hourly DLF values with both unconstrained and constrained values of T_s. Compared with corresponding ground measurements from BSRN.





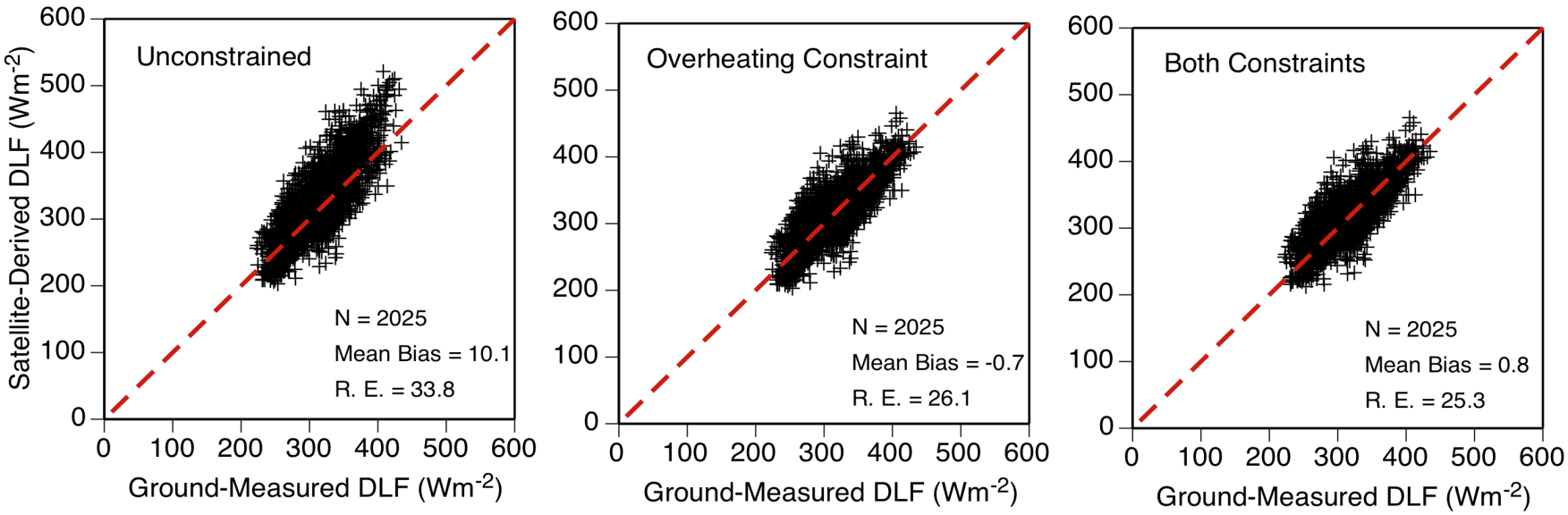
DRA Profiles Affected by Overheating





Application of Complete Methodology

- Used offline version of Model B with both constraints to compute 3-hourly values of DLF for all months of 2004. Compared them with ground measurements for DRA obtained from BSRN database.

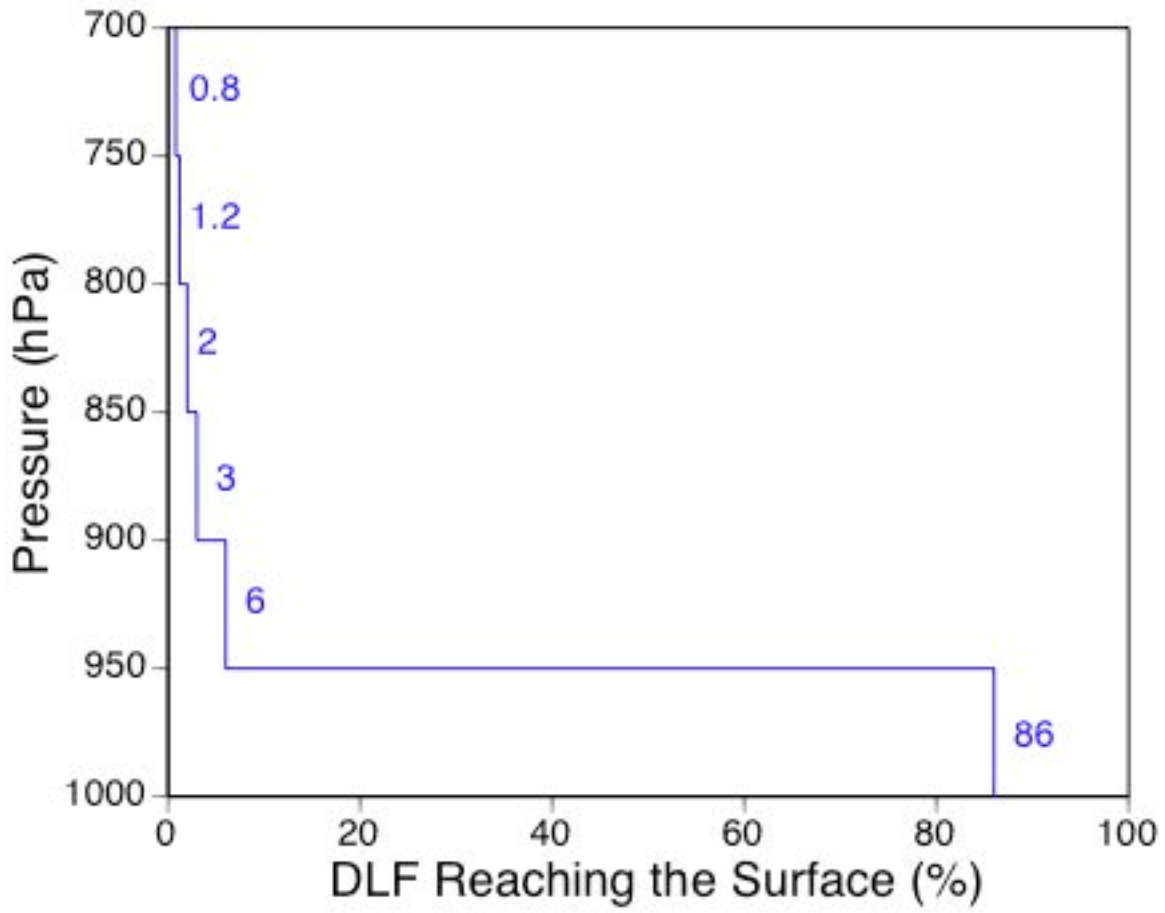


Summary and Concluding Remarks

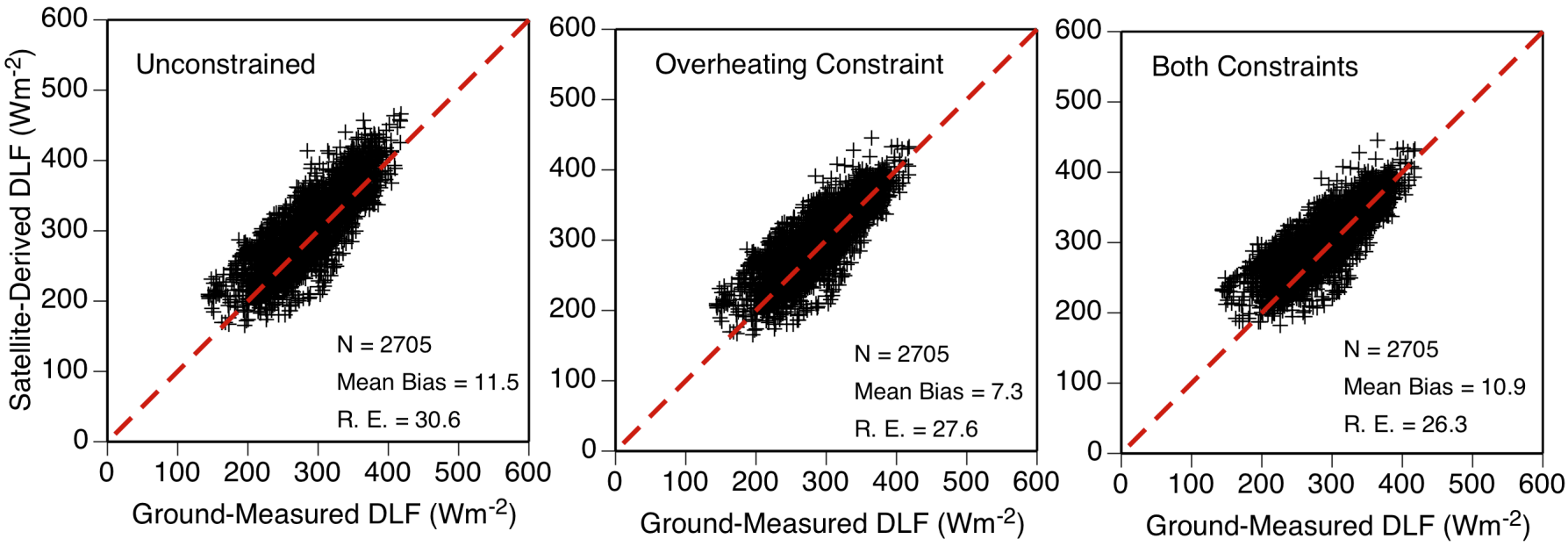
- Model deficiencies noticed during validation of surface-only fluxes are being addressed one-by-one in preparation for Edition-3.
- Developed a methodology for correcting overestimation and underestimation of DLF in SOFA LW models that occur under certain meteorological conditions.
- A manuscript on the above methodology is in preparation and should be ready for submission shortly.

Back-up Slides

Weighting Function for DLF Reaching the Surface
(Mid-Latitude Atmosphere – 50 hPa Layers)



Comparison for Fort Peck (FPK)



Surface and Atmospheric Temperatures Over Sea of Japan

January 2004